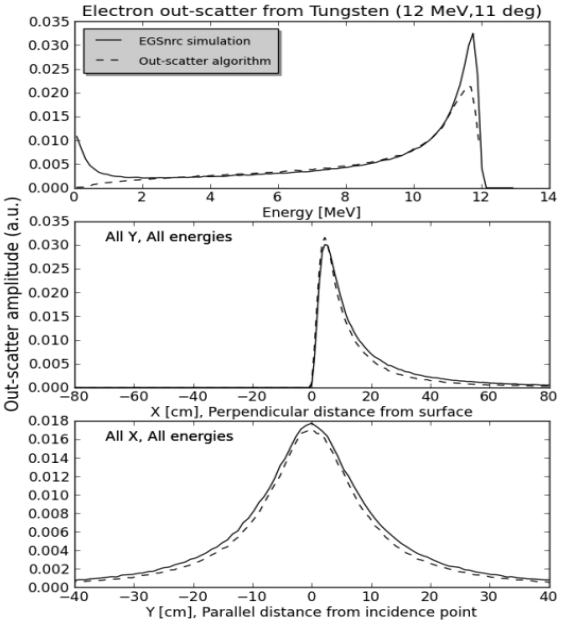
beam penumbra shifts, valley and peak doses agree within 3 % accuracy. Comparing calculations with PS and with ideal MBs shows differences of on average 8 % in the PVDR. Measurements at the ID17 beamline support the findings for polarisation effects. The PS improves the agreement with measurements but does not suffice to eliminate deviations.
Conclusions: Inside the therapeutically important MB field polarisation can be neglected. The PS, however, seems to be important. Further investigations need to be done to unravel other not yet considered influences such as total internal reflection or surface roughness of the collimators.

PD-0276
On fast simulation of electron and proton grazing incidence out-scatter from collimators
E. Traneus[1], E. Engwall[1]
[1]*RaySearch Laboratories AB, Stockholm, Sweden*

Purpose/Objective: For electron and proton treatment techniques where lateral dose conformation is achieved by collimators and patient specific apertures, out-scatter from a collimator's perimeter back into the field may contribute to as much as 10% to the in-field dose. We present a method to model out-scatter by direct Monte Carlo simulation. This method is suitable for implementation in a Monte Carlo capable treatment planning system (TPS). The goal is to achieve an efficiency such that the out-scatter phase space can be faithfully modelled while not dominating the overall time to generate a beam phase space.
Materials and Methods: The out-scatter characteristics are governed by energy loss, multiple scattering and bremsstrahlung (for electrons). We disregard discrete Møller interactions. We apply a sequence of 'random hinge' condensed history transport steps using the Goudsmit-Saunderson theory. Bremsstrahlung interactions are treated by the fictitious cross section method in an approximate manner. The method has been validated against EGSnrc and Geant4 simulations for relevant materials, incident angles and energies for electrons and protons.For protons also comparison of out-scatter measurements on Tungsten at 98 MeV and180 MeV is presented.
Results: For electrons the method is on the order of 10 times faster than an EGSnrc simulation, while it still reproduces energy spectra and spatial distributions with sufficient accuracy. Results for a 12 MeV electron beam incident at 11 degrees on a Tungsten surface are shown in the enclosed figure. Spatial positions are scored in a plane located 25 cm downstream of the point of incidence. Similar results are obtained for protons. The presented method is implemented in the electron beam model of the RayStation® TPS.



Conclusions: It is feasible to explicitly model electron or proton out-scatter from collimators with sufficient efficiency and accuracy to be included in a clinical treatment planning system.

PD-0277
Verification of Acuros XB and analytical anisotropic algorithm (AAA) in heterogeneous media
G. Defraene[1], W. Crijns[1], B. Vanstraelen[1], F. Van den Heuvel[1]
[1]*University Hospital Gasthuisberg - Radiation Oncology, Leuven, Belgium*

Purpose/Objective: Dose calculation in heterogeneous media has been a major challenge in the latest calculation algorithms. The new Acuros 10.0.0.28 algorithm implemented in Eclipse (Varian Medical Systems) for photon dose calculation directly solves the Linear Boltzmann transport equation. In this study EBT film measurements were performed within an antropomorph Alderson phantom (for a clinical IMRT lung plan), and in a setup containing cork and polystyrene (for a single field plan, simulating a lung-water transition). EBT film has the advantage that its water equivalence does not perturbate the surrounding. Measured doses were compared to predictions by the two calulation algorithms: Acuros and AAA.
Materials and Methods: A clinical 5 field 10 MV IMRT lung plan (mediastinal treatment) was delivered to an Alderson phantom on a Clinac 2100 C/D accelerator (figure 1a). A total number of 922 MU was planned for this highly modulated treatment. The clinical plan was recalculated for the Alderson setup (1mm CT) with the same monitor units. The grid size for the calculation was initially 2.5 mm for both algorithms. An EBT2 film was inserted between phantom slices 3 and 4, and between slices 5 and 6 (starting from the cranial side). Film calibration was based on two films with applied static fields. A single channel correction was implemented for the red color channel. Gamma analysis of the resulting 2D dose measurement and the calculated dose plane was performed for different dose differences (DD) and distances to agreement (DTA). In a second setup cork was inserted between two slabs of polystyrene. EBT3 film was inserted at different depths. A single 2x2 field of 6MV was delivered on TrueBeam and compared with calculations. Spot size for the Acuros calculation was 1 mm and dose to medium is reported.
Results: Table 1 reports the gamma score in percent for Acuros and AAA calculations in the Alderson setup. Our clinical threshold of 85% for DD and DTA of 3% and 3mm respectively, was not achieved in this lung setup. DD and DTA of 5% and 5 mm were required to meet the criterion, both for AAA and Acuros (and for both locations in the phantom). Acuros does not improve the prediction in this IMRT lung case (gamma score was better for slice 3-4 but worse for slice 5-6, compared to AAA). Largest errors were observed in the buildup regions between lung and mediastinum. This finding is confirmed by the results of the second setup shown in figure 1b. Acuros performs only slightly better to predict the fall-off in the first two centimeter of cork, while the rebuildup in polystyrene is not well captured.

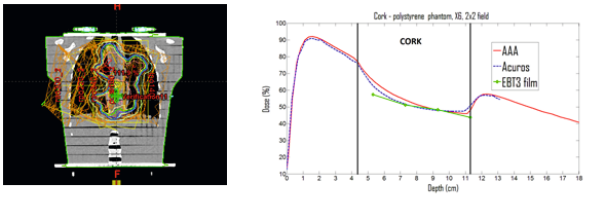


Figure 1: a) left: Alderson setup with 5 field IMRT plan
b) right: Result of the polystyrene - cork setup

	Acuros XB		AAA	
DD-DTA	Slice3-4	Slice 5-6	Slice 3-4	Slice 5-6
2% 2mm	58.1	44.4	59.7	50.7
3% 3mm	69.7	63.5	69.8	69.3
4% 4mm	79.6	78.3	78.6	80.0
5% 5mm	87.2	86.8	85.8	87.7
6% 6mm	90.7	90.8	90.3	91.6

Table 1: Gamma scores for EBT measurements in Alderson phantom

Conclusions: The improvement with Acuros compared to AAA that was observed in the cork-polystyrene setup could not be validated in a clinical IMRT lung treatment. A dose difference of 5% and distance-to-agreement of 5mm result in acceptable gamma scores, compared to 3% and 3mm in more homogeneous regions.